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July, 1919, to August, 1920, under the headings: (*a*) work in Europe; (*b*) history of science; (*c*) Leonardo studies; (*d*) history of physics in the nineteenth century; (*e*) the new humanism.

In the report on Mathematical Physics by F. R. Moulton, reference is made to the volume on *Periodic Orbits* (*1920*, 472), and to three papers on optical subjects published in *Visual Education*, Chicago. He gives the full program of his colloquium lectures before the American Mathematical Society in 1920, and he notes that "a chapter on numerical integration of differential equations has been written for a volume which is being prepared for the Smithsonian Institution by Professor E. P. Adams."

Frank Morley makes report for Mathematics as follows: "Professor Coble has published his memoir on "The ten nodes of the rational sextic and of the Cayley symmetroid" (*Amer. Jour. Math.*, vol. 41, no. 4, pp. 243–265, October 1919). He has completed a memoir on Double binary forms and the closure property,[1] which develops some new points of view and many new instances.

"Two other researches of Professor Coble which are in progress may be mentioned: In the first, the modular functions of genus 3 are used to obtain a system of irrational invariants of the ternary quartic which can be identified with a similar system arising from the set of seven points in a plane. This connects the rational invariants of the quartic with the invariants of a finite collineation group in 15 variables and would indicate that the complete system of the quartic consists of not more than 17 members.

"The second research connects his discovery that the symmetroid can be transformed by Cremona transformations into only a finite number of distinct types with the fact discovered by Schottky that the symmetroid arises from the modular functions of genus 4. Cremona transformations of the symmetroid are induced by the integer linear transformations of the modular functions, when reduced modulo 2."

Tables of the Digamma and Trigamma Functions. By Eleanor Pairman. (Tracts for Computers, edited by Karl Pearson, no. 1). Cambridge University Press, 1919. 8vo. 19 pages. Price 3 shillings.

The digamma function is $d/dz \log\Gamma(1 + z)$ and the trigamma function $d^2/dz^2 \log \Gamma(1 + z)$. Their computation facilitates the summation of series of the form

$$S = \sum_{i=1}^{\infty} \frac{a_0 + a_1 i + a_2 i^2 + \cdots + a_{n-2} i^{n-2}}{(p_1 i + q_1)(p_2 i + q_2) \cdots (p_n i + q_n)},$$

where the a's, p's and q's are numerical quantities, and any number of pairs of factors in the denominator may be equal. In work on the torsion flexure of aeroplane propeller blades it was found necessary to sum a large number of series of this form.

"It was not discovered until the present tables were almost completed that a certain portion of the work had been already performed. Gauss (*Werke*, vol. 3, pp. 161, 162 $\cdots$) gave tables of $d[\log \Gamma(1 + z)]/dz$ correct to 18 decimal places for values of z between 0 and 1, the increment in z being .01. Professor G. N. Watson (*Report of the British Association*, 1916, pp. 125, 126) gives tables of the same function correct to 13 decimal places for all integers and halves of odd integers from 0 to 100. These two valuable tables have been made use of as a check on the present 8-figure tables. So far as has been discovered there are no other tables of $d^2 [\log \Gamma(1 + z)]/dz^2$."

Prefatory note by K. Pearson: "During the course of the past five years the Department of Applied Statistics in the University of London (University College) has carried out a great deal of computing work of one kind or another bearing on special war problems of a physical character. Its members have been struck by the absence of any simple text-book for the use of computers and still more by the absence of obviously necessary auxiliary tables. The present series of *Tracts for Computers* will endeavour to fill this gap as far as it lies in our power. It will not concern itself with the higher mathematical theory, but solely with the practical difficulties of the computer, or rather such difficulties as we have met with in our own experience. The first tract will be followed not only by others containing recently computed tables or by the republication of old tables at present very inaccessible, but by tracts dealing with interpolation, quadrature, mechanical integration, calculating machines, tabling machines, and bibliographies of memoirs, and of tables having special value to the practical computer. In regard to the present tract, giving the values of the digamma and trigamma functions, we should ourselves have been saved many weeks of work had it been in existence four years ago. Further, we believe it will be of help not only in many physical problems other than those we have had to deal with ourselves, but to the schoolmaster who grasps the urgent importance of teaching practical mathematics to the modern school boy. The table of logarithms is not the only table that a schoolboy should learn to handle. In most modern computing laboratories a table of logarithms is very rarely used—and when used it is generally one to 10 or 14 figures[1] where multiplications are necessary which exceed the range of the ordinary multiplying machine. Nowadays the schoolboy ought to be practised in computing, and this practice should run parallel with his algebraic work. He should be exercised in the use of tables which are not becoming obsolete like the smaller tables of logarithms. He comes at a fairly early stage to the summation of series and he is liable to regard certain series as unsummable because he has not approached them numerically, just as he unfortunately regards certain integrals as unintegrable, because he is not introduced at a quite early stage to graphical, mechanical and numerical methods of quadrature. The present tract covers a very wide class of numerically summable series, and we can conceive no better practice than the schoolmaster could provide for his pupils by teaching them to sum all such series by tabular aid. If the pupil be asked at the same time to compare the result obtained by summing directly 15 to 20 terms of the series set (using tables of logarithms if he likes!), he will have learnt during the process a good deal of the practical value of logarithms, of tests for convergency, of partial fractions, of interpolation and of the value of tabular aids to the computer. He will further have realised that 'proportional parts' are neither the sole nor necessarily adequate method of entering a table;—a belief not indeed infrequently found to dominate the post-graduate as well as the school boy mind and probably arising from the same limitation of experience—the very words 'mathematical tables' being treated as synonymous with the smaller tables of common and trigonometrical logarithms."

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[1] A memoir by Professor Coble, entitled "Multiple binary forms with the closure property," was published in *Amer. Jour. Math.*, vol. 43, January, 1921, pp. 1–19.—Editor.

On the Construction of Tables and on Interpolation. Part I: Uni-variate Tables; Part II: Bi-variate Tables. By Karl Pearson. (Tracts for Computers, edited by K. Pearson, nos. 2, 3). Cambridge University Press, 1920. 8vo. 54 + 70 pages. Price $3\frac{3}{4}$ + $3\frac{3}{4}$ shillings.

Prefatory note: "These tracts do not profess to be a complete treatise on the construction of mathematical tables, still less a full mathematical treatment of interpolation. They put together some of the practical processes, which have been found of service in the Biometric Laboratory, and state some of the difficulties which have arisen in very heavy recent computations and I would draw the attention of the pure mathematician to the necessity for their solution. As far as I am aware, but I have not made a wide search of the literature, the bi-variate central difference formulae provided are novel. They are those which naturally arise, however, when we come to deal with tables of double entry in practice.

"The main doctrine insisted on is that in ordinary mathematical tables accuracy would be gained if the tabulation of first differences were replaced by the tabulation of first central differences, and that in bi-variate tables the tabulation of the two first central differences of both variates is in the bulk of cases the sole method by which the material can be reduced within the bounds of possible publication."

On pages 62–70 of Tract no. 2, there is an annotated list of fifty works and memoirs dealing with interpolation from 1624 down to the present.

Tables of the Logarithms of the Complete Γ-function to twelve Figures. (Tracts for Computers, edited by Karl Pearson, no. 4.) Cambridge University Press. 4to. 1921. 14 pages + portrait frontispiece of Legendre. Price $3\frac{3}{4}$ shillings.

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[1] "And where in seeking the antilog. the school boy's knowledge of the process is idle!"